

5. (Currently Amended) The precoder according to claim 2, wherein the mapper comprises:

a table identifying the basic constellation of levels and a mapping from the set of levels outside the basic constellation of levels to levels inside the basic constellation of levels.

6. (Currently Amended) The precoder according to claim 1, wherein each of the set of levels outside the basic constellation of levels is mapped onto only one level inside the basic constellation of levels.

7. (Currently Amended) The precoder according to claim 2, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from ~~1~~1-k to k, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index positive\_const, where the positive\_const goes from k+1 to m, associated with a plurality of levels outside the basic constellation of levels, wherein said k is a constant and said m is a multiple of said k.

8. (Currently Amended) The precoder according to claim 7, wherein each of the plurality of levels outside the basic constellation of levels <sup>index</sup> ~~index are~~ <sup>is</sup> mapped onto a level inside the basic constellation of levels according to the equation:

index positive\_const → positive\_const  $[-] - (2*k)$ ; while positive\_const > m-k; and

index positive\_const → positive\_const  $[-] - (2*k) - 1$ ; while positive\_const ≤ m-k;

wherein → identifies a ~~the~~ mapping function.

9. (Currently Amended) The precoder according to claim 2, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from -k to k ~~-1 to k~~, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index negative\_const, where the negative\_const goes from -k-1 to -m, associated with a plurality of levels outside the basic constellation of levels.

10. (Currently Amended) The precoder according to claim 9, wherein each <sup>index</sup> of the plurality of levels outside the basic constellation of levels <sup>is</sup> ~~index are~~ mapped onto a level inside the basic constellation of levels according to the equation:

$\text{index negative\_const} \rightarrow \text{negative\_const} + (2*k); \text{ while } \text{negative\_const} < -(m-k); \text{ and}$

$\text{index negative\_const} \rightarrow \text{negative\_const} + (2*k)+1; \text{ while } \text{negative\_const} \geq -(m-k);$

wherein  $\rightarrow$  identifies a the mapping function.

11. (Original) The precoder according to claim 7, wherein the mapper further comprises a comparator for comparing the partial result with the levels in the table.

12. (Original) The precoder according to claim 11; wherein the comparator identifies the level closest to the partial result.

13. (Currently Amended) The precoder according to claim 12, wherein <sup>the</sup> ~~a~~ the mapper further includes an output block that generates a the mapped constellation signal equal to a level inside the basic constellation of levels, if the identified level in the table closest to the partial result is inside the basic constellation of levels.

14. (Currently Amended) The precoder according to claim 13, wherein the ~~output block~~ includes a summer for adding mapped constellation signal is set equal to the sum of the partial result and a mapping distance signal, wherein the mapping distance signal equals the distance between the index basic\_const, associated ~~associate~~ with the basic constellation level of the input signal, and the index positive\_const, associated with a level outside the basic constellation of levels.

15. (Original) The precoder according to claim 1, further comprising a digital to analog converter that generates an analog output signal based upon the mapped constellation signal.

16. (Previously Presented) The precoder according to claim 15, further comprising a hybrid for operably coupling the digital to analog converter to an analog subscriber loop.

17. (Currently Amended) The precoder according to claim 1, wherein successive levels in the basic constellation of levels are separated by a distance D1, and wherein a plurality of successive levels outside the basic constellation of levels ~~are~~ is separated by a distance D2 such that D1 differs from D2.

18. (Currently Amended) A precoder for an analog modem, the precoder comprising:  
a processing element that generates <sup>a</sup>~~the~~ mapped constellation signal as a function of a feedback signal and an input signal to the precoder, the processing element including:

an adder that adds together the feedback signal and the input signal to generate a partial result,

a table identifying a basic constellation of levels and levels outside the basic constellation of levels, wherein the levels outside the basic constellation of levels are mapped onto levels

inside the basic constellation of levels as a function of an index associated with each level in the table,

an output block that generates <sup>the</sup> ~~a~~ mapped constellation signal equal to a level inside the basic constellation of levels by mapping a partial result outside the basic constellation of levels onto a level inside the basic constellation of levels, and

a feedback filter that generates the feedback signal as a function of the mapped constellation signal output by the processing element.

19. (Currently Amended) The precoder according to claim 18, wherein each of the levels outside the basic constellation of levels in the table ~~are~~<sub>is</sub> mapped onto only one level inside the basic constellation of levels in the table.

20. (Currently Amended) The precoder according to claim 18, further comprising:

~~a~~<sub>the</sub> table having a constellation index basic\_const, where ~~the~~ basic\_const goes from ~~1-k~~ to k, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index positive\_const, where ~~the~~ positive\_const goes from k+1 to m, associated with a plurality of levels outside the basic constellation of levels.

21. (Currently Amended) The precoder according to claim 20, wherein each <sup>index</sup> ~~of~~ the plurality of levels outside the basic constellation of levels ~~index~~ ~~are~~<sub>is</sub> mapped onto a level inside the basic constellation of levels according to the equation:

index positive\_const → positive\_const  $[(\quad)] - (2*k)$ ; while positive\_const > m-k; and

index positive\_const → positive\_const - (2\*k)-1; while positive\_const ≤ m-k;

wherein → identifies ~~a~~ the mapping function.

22. (Currently Amended) The precoder according to claim 18, further comprising:  
a table having a constellation index basic\_const, where the basic\_const goes from  $-k$  to  $[(k-1)]$ , associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index negative\_const, where the negative\_const goes from  $-k-1$  to  $-m$ , associated with a plurality of levels outside the basic constellation of levels.

23. (Currently Amended) The precoder according to claim 22, wherein each of the plurality of levels outside the basic constellation of levels <sup>index</sup> ~~index~~ <sup>are</sup> mapped onto a level inside the basic constellation of levels according to the equation:

$\text{index negative\_const} \rightarrow \text{negative\_const} + (2*k); \text{ while } \text{negative\_const} < -(m-k); \text{ and}$

$\text{index negative\_const} \rightarrow \text{negative\_const} + (2*k) + 1; \text{ while } \text{negative\_const} \geq -(m-k);$

wherein  $\rightarrow$  identifies a ~~the~~ mapping function.

24. (Currently Amended) The precoder according to claim 20, wherein the ~~output block~~ includes a summer for adding mapped constellation signal is set equal to the sum of the partial result and a mapping distance signal, wherein the mapping distance signal equals the distance between the index basic\_const, associated with the basic constellation level of the input signal, and the index positive\_const, associated with a level outside the basic constellation of levels.

25. (Previously Presented) A method of precoding an input signal to generate a mapped constellation signal, comprising:

generating a feedback signal from the mapped constellation signal by multiplying a delayed version of the mapped constellation signal by a weighting element, and

constellation of levels or whether the partial result is greater than a maximum level of the basic constellation of levels.

31. (Currently Amended) The method according to claim 30, further including a step of determining a mapping distance  $p_j$  when the partial result is less than the minimum level of the basic constellation of levels, the mapping distance  $p_j$  being equal to a distance between an index  $basic\_const$ , associated with ~~the~~a basic constellation level of the input signal, and an index  $positive\_const$ , associated with a level outside the basic constellation of levels, wherein said j represents said basic constellation level of the input signal and said level outside the basic constellation of levels.

32. (Currently Amended) The method according to claim 31, wherein the index  $positive\_const$  is an index to a level that maps onto the basic constellation level of the input signal, and wherein the index  $positive\_const$  is an index to a level in a positive constellation of levels that includes those levels greater than the maximum <sup>level</sup> ~~in~~ the basic constellation of levels.

33. (Previously Presented) The method according to claim 32, further including a step of obtaining the index  $positive\_const$  from <sup>the</sup> ~~a~~ table.

34. (Currently Amended) The method according to claim 31, further including a step of generating ~~a~~the mapped constellation signal by adding together the partial result and the mapping distance  $p_j$ .

35. (Currently Amended) The method according to claim 30, further including a step of determining a mapping distance  $n_j$ , when the partial result is greater than the maximum level of the basic constellation of levels, the mapping distance  $n_j$  being equal to a distance between an

index basic\_const, associated with ~~the~~a basic constellation level of the input signal, and an index negative\_const, associated with a level outside the basic constellation of levels, wherein j represents said basic constellation level of the input signal and said level outside the basic constellation of levels.

36. (Currently Amended) The method according to claim 35, wherein the index negative\_const is an index to a level that maps onto the basic constellation level of the input signal, and wherein the index negative\_const is an index to a level in a negative constellation of levels that includes those levels less than the minimum level in the basic constellation of levels.

37. (Original) The method according to claim 36, further including the step of obtaining the index negative\_const from <sup>the</sup>~~a~~ table.

38. (Currently Amended) The method according to claim 35, further including the step of generating the mapped constellation signal by adding together the partial result and the mapping distance  $n_j$ .

39. (Previously Presented) A computer-readable medium having stored thereon a plurality of instructions, the plurality of instructions including instructions that when executed by a processor cause the processor to implement a method of precoding an input signal to generate a mapped constellation signal, the method comprising:

generating a feedback signal from the mapped constellation signal, and

performing an operation on the feedback signal and the input signal based upon an index to a constellation of levels chosen for a precoder, wherein the constellation of levels includes a

50. (Previously Presented) The apparatus according to claim 49 further including a feedback filter having a delay element and a weighting element such that the feedback filter multiplies a delayed version of the mapped constellation signal by the weighting element to generate the feedback signal.

51. (Currently Amended) The apparatus according to claim 49 further including a feedback filter coupled to said precoder and based upon a model of an impulse response of a communication channel.

52. (Currently Amended) The apparatus according to claim 49 wherein the precoder employs an adder that adds together the feedback signal and the input signal to generate a partial result and a mapper that generates the mapped constellation signal by mapping a partial result outside the basic constellation of levels onto the basic constellation of levels as a function of the index to the constellation of levels, the mapper having a table to identify the basic constellation of levels and associate levels outside the basic constellation of levels to levels inside the basic constellation of levels.

53. (Currently Amended) The apparatus according to claim 49 wherein each of the levels outside the basic constellation of levels ~~are~~ is only associated with one level inside the basic constellation of levels.

54. (Currently Amended) The apparatus according to claim <sup>52</sup>~~49~~ further comprising <sub>^</sub>  
wherein the precoder includes a table that identifies the basic constellation of levels, wherein the table has a constellation index basic\_const, where the basic\_const goes from 1-k to k, associated with each of a plurality of levels inside the basic constellation of levels, and wherein the



~~precoder~~table has a constellation index positive\_const, where the positive\_const goes from  $k+1$  to  $m$ , associated with a plurality of levels outside the basic constellation of levels, wherein said  $k$  is a constant and said  $m$  is a multiple of said  $k$ .

55. (Currently Amended) The apparatus according to claim 54 wherein the precoder maps each of the plurality of levels outside the basic constellation of levels ~~index~~ onto a level inside the basic constellation of levels according to the equation:

$\text{index positive\_const} \rightarrow \text{positive\_const}[[ - ] - (2*k)];$  while  $\text{positive\_const} > m-k;$  and

$\text{index positive\_const} \rightarrow \text{positive\_const}[[ - ] - (2*k)-1];$  while  $\text{positive\_const} \leq m-k;$

wherein  $\rightarrow$  identifies ~~a~~ the mapping function.

56. (Currently Amended) The apparatus according to claim 49 ~~further comprising a~~  
*wherein includes a table*  
~~table~~the precoder that identifies the basic constellation of levels, wherein the table has a constellation index basic\_const, where the basic\_const goes from  $-k$  to  $k$   $[[ -1 \text{ to } -k ]]$ , associated with each of a plurality of levels inside the basic constellation of levels, and wherein the ~~precoder~~table has a constellation index negative\_const, where the negative\_const goes from  $-k-1$  to  $-m$ , associated with a plurality of levels outside the basic constellation of levels, wherein said  $k$  is a constant and said  $m$  is a multiple of said  $k$ .

57. (Currently Amended) The apparatus according to claim 56 wherein the precoder maps each of the plurality of levels outside the basic constellation of levels ~~index~~ onto a level inside the basic constellation of levels according to the equation:

$\text{index negative\_const} \rightarrow \text{negative\_const} + (2*k);$  while  $\text{negative\_const} < -(m-k);$  and

$\text{index negative\_const} \rightarrow \text{negative\_const} + (2*k)+1;$  while  $\text{negative\_const} \geq -(m-k);$

wherein → identifies a the mapping function.

58. (Previously Presented) The apparatus according to claim 52 wherein the mapper further comprises a comparator for comparing the partial result with the levels in the table.

59. (Previously Presented) The apparatus according to claim 58 wherein the comparator identifies the level closest to the partial result.

60. (Currently Amended) The apparatus according to claim 59 wherein the mapper further includes an output block that generates athe mapped constellation signal equal to a level inside the basic constellation of levels, if the identified level in the table closest to the partial result is inside the basic constellation of levels.

61. (Currently Amended) The apparatus according to claim <sup>54</sup>~~60~~, wherein the ~~output block~~ <sup>includes a summer for adding</sup> mapped constellation signal is set equal to the sum of the partial result and a mapping distance signal, wherein the mapping distance signal equals the distance between the index basic\_const, associated with ~~the~~a basic constellation level of the input signal, and the index positive\_const, associated with a level outside the basic constellation of levels.

62. (Canceled)

63. (Currently Amended) The apparatus according to claim 49 wherein a plurality of index values ~~are~~is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

64. (Currently Amended) The precoder according to claim 1 wherein a plurality of index values ~~are~~is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

*Cancelled*  
65. (~~Currently Amended~~) ~~The precoder according to claim 18 wherein a plurality of index values are~~is ~~associated, respectively, with a plurality of amplitude levels in a the constellation of levels.~~

66. (Currently Amended) The method of precoding according to claim 25 wherein a plurality of index values are~~is~~ associated, respectively, with a plurality of amplitude levels in the constellation of levels.

67. (Currently Amended) The computer-readable medium of claim 39 wherein a plurality of index values are~~is~~ associated, respectively, with a plurality of amplitude levels in the constellation of levels.

68. (Previously Presented) A precoder for generating a mapped constellation signal, from an input signal, comprising:

a feedback filter, including a delay element and a weighting element, that generates a feedback signal as a function of the mapped constellation signal by multiplying a delayed version of the mapped constellation signal by the weighting element, and

a processing element that generates the mapped constellation signal from the input signal and the feedback signal, the processing element utilizing an index to a constellation of levels chosen for the precoder, wherein the constellation of levels includes a basic constellation of levels and a set of levels outside the basic constellation of levels, such that the amplitude of the mapped constellation signal is limited.

69. (Previously Presented) The precoder according to claim 68, wherein the processing element comprises:

an adder that adds together the feedback signal and the input signal to generate a partial result, and

a mapper that generates the mapped constellation signal by mapping a partial result outside the basic constellation of levels onto the basic constellation of levels as a function of the index to the constellation of levels for the precoder.

70. (Currently Amended) The precoder according to claim 69, wherein the mapper ~~further~~ comprises:

a table identifying the basic constellation of levels and a mapping from the set of levels outside the basic constellation of levels to levels inside the basic constellation of levels.

71. (Currently Amended) The precoder according to claim 68, wherein each of the levels outside the basic constellation of levels is mapped onto only one level inside the basic constellation of levels.

72. (Currently Amended) The precoder according to claim 69, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from 1-k to k, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index positive\_const, where the positive\_const goes from k+1 to m, associated with a plurality of levels outside the basic constellation of levels.

73. (Currently Amended) The precoder according to claim 69, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from  $-k$  to  $[[(-)]k$  ~~basic\_const goes from -1 to k~~, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index negative\_const, where the negative\_const goes from  $-k-1$  to  $-m$ , associated with a plurality of levels outside the basic constellation of levels.

74. (Previously Presented) The precoder according to claim 72, wherein the mapper further comprises a comparator for comparing the partial result with the levels in the table.

75. (Previously Presented) The precoder according to claim 74, wherein the comparator identifies the level closest to the partial result.

76. (Currently Amended) The precoder according to claim 75, wherein the mapper further includes an output block that generates athe mapped constellation signal equal to a level inside the basic constellation of levels, if the identified level in the table closest to the partial result is inside the basic constellation of levels.

77. (Previously Presented) The precoder according to claim 68, further comprising a digital to analog converter that generates an analog output signal based upon the mapped constellation signal.

78. (Previously Presented) The precoder according to claim 77, further comprising a hybrid for operably coupling the digital to analog converter to an analog subscriber loop.

79. (Currently Amended) The precoder according to claim 68 wherein a plurality of index values ~~are~~is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

a table identifying the basic constellation of levels and a mapping from the set of levels outside the basic constellation of levels to levels inside the basic constellation of levels.

83. (Currently Amended) The precoder according to claim 80, wherein each of the levels outside the basic constellation of levels is mapped onto only one level inside the basic constellation of levels.

84. (Currently Amended) The precoder according to claim 81, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from  $1-k$  to  $k$ , associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index positive\_const, where the positive\_const goes from  $k+1$  to  $m$ , associated with a plurality of levels outside the basic constellation of levels.

85. (Currently Amended) The precoder according to claim 81, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from  $-1k$  to  $[[ - ] ] k$  ~~basic\_const goes from -1 to k~~, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index negative\_const, where the negative\_const goes from  $-k-1$  to  $-m$ , associated with a plurality of levels outside the basic constellation of levels.

86. (Previously Presented) The precoder according to claim 84, wherein the mapper further comprises a comparator for comparing the partial result with the levels in the table.

91. (Currently Amended) The apparatus according to claim 90 wherein each of the levels outside the basic constellation of levels ~~are~~is only associated with one level inside the basic constellation of levels.

92. (Currently Amended) The apparatus according to claim 90 ~~further comprising a~~  
*wherein includes a table*  
~~table~~the precoder that identifies the basic constellation of levels, wherein the table has a constellation index basic\_const, where the basic\_const goes from -k to k ~~[[ -1 to -k ]]~~, associated with each of a plurality of levels inside the basic constellation of levels, and wherein the ~~precoder~~table has a constellation index negative\_const, where the negative\_const goes from -k-1 to -m, associated with a plurality of levels outside the basic constellation of levels.

93. (Currently Amended) The apparatus according to claim 92 wherein ~~the precoder~~  
*the precoder*  
~~the mapper~~  
maps each of the plurality of levels outside the basic constellation of levels ~~index~~ onto a level inside the basic constellation of levels according to the equation:

index negative\_const  $\rightarrow$  negative\_const + (2\*k); while negative\_const  $<$  -(m-k); and

index negative\_const  $\rightarrow$  negative\_const + (2\*k)+1; while negative\_const  $\geq$  -(m-k);

wherein  $\rightarrow$  identifies a ~~the~~ mapping function.

94. (Currently Amended) The apparatus according to claim 90 wherein successive levels in the basic constellation of levels are separated by a distance D1, and wherein a plurality of successive levels outside the basic constellation of levels ~~are~~is separated by a distance D2 such that D1 differs from D2.

95. (Currently Amended) The apparatus according to claim 90 wherein a plurality of index values ~~are~~is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

96. (Currently Amended) An apparatus for generating a mapped constellation signal from an input signal, comprising:

a feedback filter based upon a model of an impulse response of a communication channel that generates a feedback signal, and

a precoder configured to generate~~[[ ]]~~ the mapped constellation signal from the input signal and the feedback signal, wherein the precoder utilizes a constellation of levels that include a basic constellation of levels and a set of levels outside the basic constellation of levels, and wherein the precoder is configured to associate an index with each of the levels in the constellation of levels such that the levels outside the basic constellation of levels are associated with the levels inside the basic constellation of levels.

97. (Currently Amended) The apparatus according to claim 96 wherein each of the levels outside the basic constellation of levels ~~are~~is only associated with one level inside the basic constellation of levels.

98. (Currently Amended) The apparatus according to claim 96 ~~further comprising a~~  
*wherein includes a table*  
~~table~~the precoder that identifies the basic constellation of levels, wherein the table has a constellation index basic\_const, where the basic\_const goes from -k to k ~~[[ -1 to -k ]]~~, associated with each of a plurality of levels inside the basic constellation of levels, and wherein the



109. (Currently Amended) The apparatus according to claim 106 ~~further comprising~~  
~~awherein the~~ table that identifies the basic constellation of levels, wherein the table has ~~a~~the  
constellation index basic\_const, where ~~the~~ basic\_const goes from ~~-k to k~~  $[-1 \text{ to } -k]$ , associated  
with each of ~~a~~the plurality of levels inside the basic constellation of levels, and wherein the  
~~precoder~~table has a constellation index negative\_const, where ~~the~~ negative\_const goes from  $-k-1$   
to  $-m$ , associated with a plurality of levels outside the basic constellation of levels.

110. (Currently Amended) The apparatus according to claim 109 wherein <sup>the precoder</sup>~~a~~ ~~the mapper~~  
maps each of the plurality of levels outside the basic constellation of levels ~~index~~ onto a level  
inside the basic constellation of levels according to the equation:

index negative\_const  $\rightarrow$  negative\_const +  $(2*k)$ ; while negative\_const  $< -(m-k)$ ; and

index negative\_const  $\rightarrow$  negative\_const +  $(2*k)+1$ ; while negative\_const  $\geq -(m-k)$ ;

wherein  $\rightarrow$  identifies ~~a~~ the mapping function.

111. (Currently Amended) The apparatus according to claim 109 wherein <sup>the precoder</sup>~~a~~ ~~the mapper~~  
further comprises a comparator for comparing a partial result with the levels in the table.

112. (Previously Presented) The apparatus according to claim 111 wherein the  
comparator identifies the level closest to the partial result.

113. (Currently Amended) The apparatus according to claim 112 wherein <sup>precoder</sup>~~the mapper~~  
further includes an output block that generates ~~a~~ the mapped constellation signal equal to a level  
inside the basic constellation of levels, if the identified level in the table closest to the partial  
result is inside the basic constellation of levels.